7 A particle P is projected from a point O with speed U at an angle 45° above the horizontal and moves freely under gravity.

(a) State the vertical and horizontal components of velocity at time t. [1]

At time T, particle P is moving at an angle of 60° below the horizontal.

(b) Show that $T = \frac{U}{2g}\left(\sqrt{2} + \sqrt{6}\right)$. [3]

At time T, the particle strikes a smooth horizontal plane at a point which is a horizontal distance D from O and a vertical distance H below O.

(c) Find the ratio $H : D$. [4]

After striking the horizontal plane, P rebounds with speed w. The coefficient of restitution between P and the plane is $\frac{2}{3}$.

(d) Find w in terms of U. [3]

Additional page

If you use the following page to complete the answer to any question, the question number must be clearly shown.